

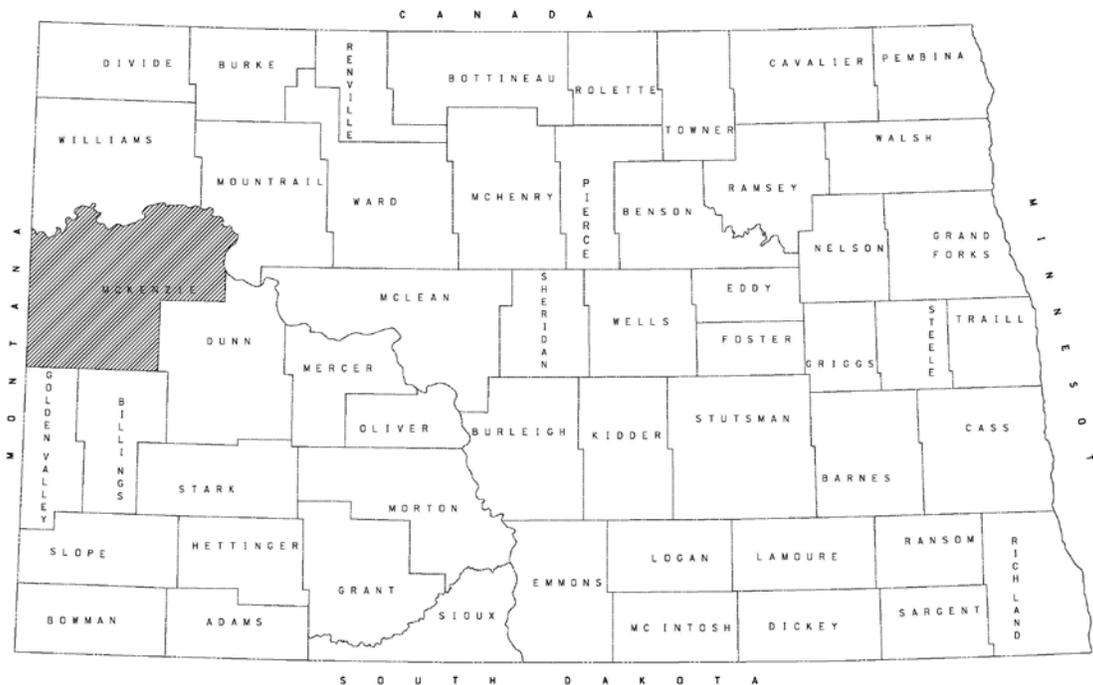
LINEAR SOIL SURVEY AND RECOMMENDATIONS ADDENDUM

PROJECT NO. SOIA-7-085(064)160

PCN 19326

COUNTY McKenzie

Highway 85 Alexander Bypass



PREPARED BY: Matthew C. Kurle, P.E.

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

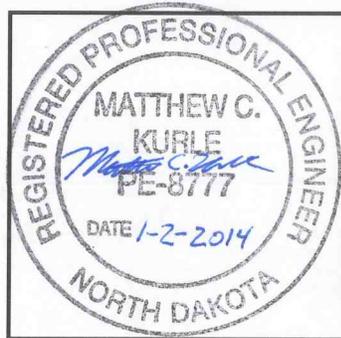
December 2013

SOIA-7-085(064)160

Alexander Bypass

CERTIFICATION

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the State of North Dakota. This document was originally issued and sealed by Matthew C. Kurle, Registration number PE-8777 on 1/2/2014 and the original document is stored at the North Dakota Department of Transportation.



Matthew C. Kurle
Matthew C. Kurle, P.E.

2 JAN 2014
Date

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Linear Soils Survey Addendum

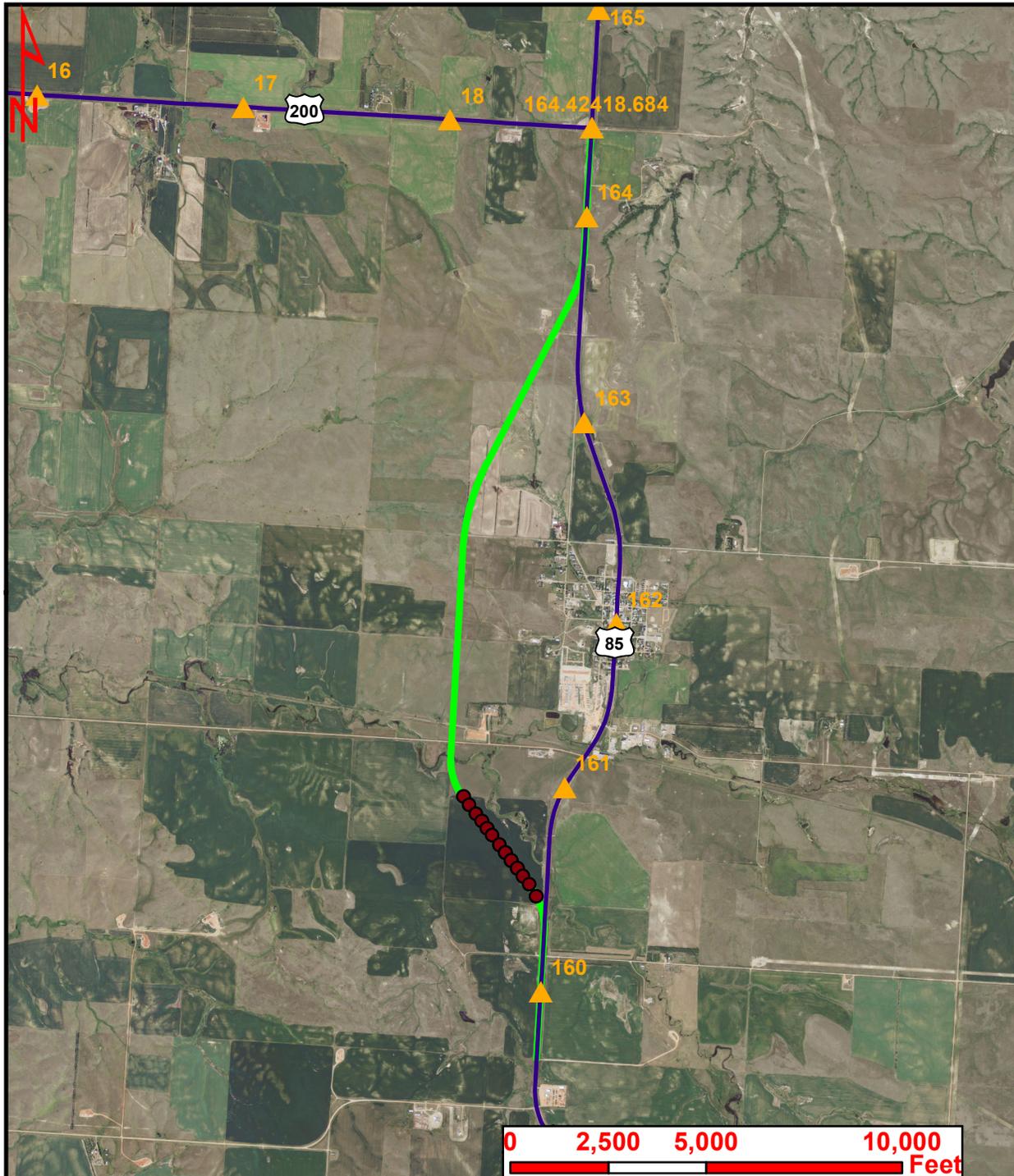
Project: SOIA-7-085(064)160

PCN: 19326

Scope: New Construction

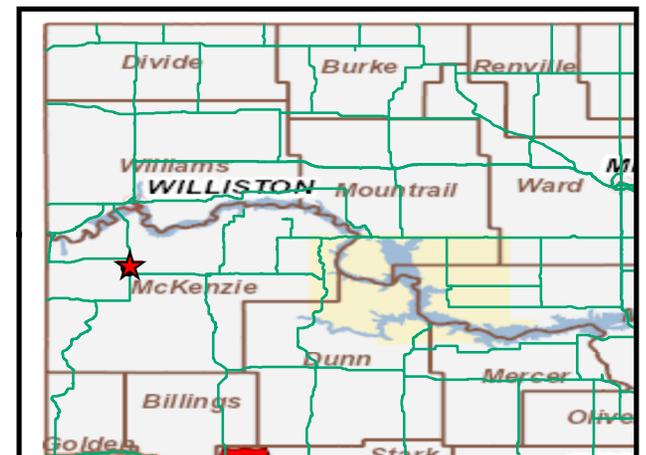
Length: 3.5 Miles

Location: Alexander Bypass



Legend

- Highway
- Boring Locations
- ▲ Reference Points
- Bypass



Introduction

This addendum will provide additional soils information and recommendations for the proposed Alexander Bypass on Highway 85. This report contains information and recommendations on the areas that were not accessible during the time the original report was written. This Report is based on the Alternative B alignment and profile provided by KLJ Engineering. This alignment is shown in Appendix B.

Soil Borings

The soil borings were performed from 11/5/2013 to 11/6/2013 using a 6 inch solid flight auger. Thirteen borings were conducted along the proposed alignment in the areas that were previously inaccessible. This alignment can be found in Appendix B of this report. The borings were advanced at variable depths based on the proposed profile.

Summary of Soil Analysis

Soil Sample Distribution

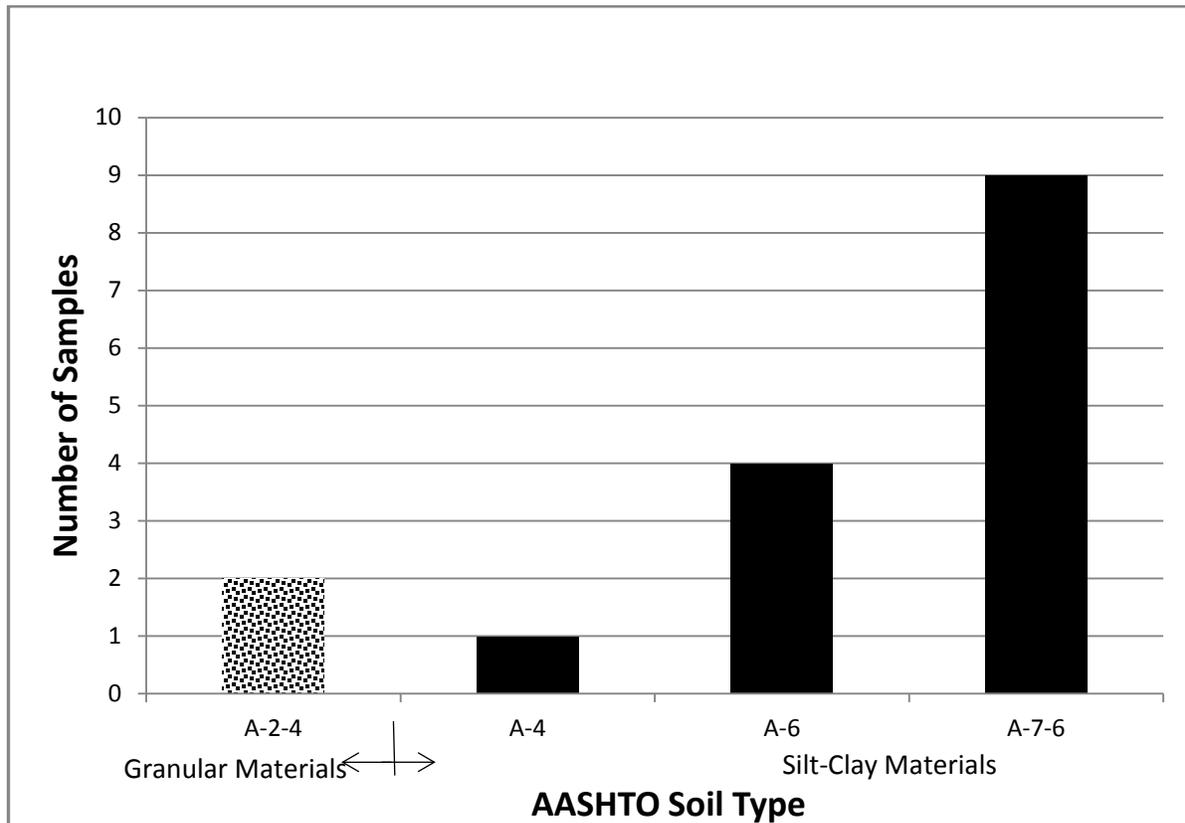


Figure 1 - Soil Sample Distribution

Moisture

The moisture contents provided in this report and summarized below have been obtained from samples taken on 11/5/13 and 11/6/13.

Table 1 - Summary of In-Place and Optimum Moisture Contents

Quantity	AASHTO Classification	In-Place Moisture Range (%)	In-Place Moisture Average (%)	T-180 Optimum Moisture Average (%)	Difference Between Average In-Place and T-180 Optimum Moistures (%)
2	A-2-4	13.4-14.5	14.0	8.9	5.1
1	A-4	-	11.5	11.0	0.5
4	A-6	20.0-23.3	21.7	11.8	9.9
9	A-7-6	17.0-29.3	22.0	13.2	8.9

Table 2 - Summary of In-Place versus Optimum Moisture Content

In-Place Moisture vs. Optimum Moisture						
Quantity	AASHTO Classification	Below Optimum	Optimum to Moderate (0 to 6% over optimum)	Moderate to High (6 to 10% over optimum)	High (10 to 16% over optimum)	Very High (> 16% over optimum)
2	A-2-4	0%	100%	0%	0%	0%
1	A-4	0%	100%	0%	0%	0%
4	A-6	0%	0%	50%	50%	0%
9	A-7-6	0%	11%	67%	22%	0%

Atterberg Limits

Table 3 - Summary of Atterberg Limits

AASHTO Classification	Liquid Limit Range (%)	Liquid Limit Average (%)	Plastic Limit Range (%)	Plastic Limit Average (%)	Plasticity Index Range (%)	Plasticity Index Average (%)
A-2-4	-	0	-	0	-	0
A-4	-	0	-	0	-	0
A-6	35-40	37	13-18	15	18-27	22
A-7-6	42-67	51	15-20	18	27-47	33

Swell Potential

The swell potential, which is based on the Plasticity Index (PI), is shown in the following table.

Table 4 - Swell Potential

Low (Plasticity Index < 25)	Marginal (25 ≤ Plasticity Index ≤ 35)	High (Plasticity Index > 35)
38%	38%	25%

Frost Susceptibility

All of the samples were classified as F3 soils.

Group Index

The Group Index is a parameter used to evaluate the quality of a soil as a subgrade material. The group index is always zero for A-1, A-2 and A-3 soils (Granular Soils). A group index of 20 or greater indicates a “very poor” subgrade material. The group indices are summarized in the following table.

Table 5 - Group Indices

AASHTO Classification	Group Index Range	Group Index Average
A-2-4	0-0	0
A-4	0-0	0
A-6	11-18	14
A-7-6	16-50	28

Design Recommendations

The analysis of the soils shows that the moisture contents were on average, 8.1% above the T-180 optimum moisture contents. The majority of the soil has acceptable engineering properties and is performing well. In the cut areas, moisture contents will be higher as the cut gets deeper. The soils at the proposed subgrade elevation beginning near Sta 8505+00 were identified as having the potential to perform poorly. In this area we recommend that 300 feet of 18 inch subcut be performed.

Additional review of the soils data from the Linear Soils Survey dated 9-9-2013 indicates that soils with poor engineering properties will be encountered at the proposed subgrade elevation from Sta 8553+00 to Sta 8561+00. In this area we recommend that 800 feet of 18 inch subcut be performed.

Design Information

Compaction Method: T-180

Subcut:

Table 6 – Subcut Recommendations

Location	Depth
Sta 8505+00 to 8508+00	18 inches below proposed subgrade elevation
*Sta 8508+00 to 8512+00	18 inches below proposed subgrade elevation
Sta 8553+00 to 8561+00	18 inches below proposed subgrade elevation

*Subcut recommendation from original report dated 9-9-2013

Subgrade Prep: 18 inches

Perform Subgrade Preparation at the proposed subgrade elevation of all cut areas and areas of 18 inches or less of fill. Exclude Subgrade Preparation from the areas where subcut is being performed. Show Subgrade Preparation areas in the Basis of Estimate in tabular form.

The recommendations in this report are based on the scope specified in the Introduction. If the scope of work, vertical profile or horizontal alignment is changed, in either the conceptual phase or the design phase, the Geotechnical Engineer must be notified as soon as possible to ensure that there is adequate geotechnical information addressing these areas.

APPENDIX A

Soil Classification and Frost Susceptibility

AASHTO Soil Classification System

Table 5.1. AASHTO Classification System

General Classification	Granular materials (35% or less passing No. 200 Sieve (0.075 mm))							Silt-clay Materials More than 35% passing No. 200 Sieve (0.075 mm)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
(a) Sieve Analysis: Percent Passing											
(i) 2.00 mm (No. 10)	50 max										
(ii) 0.425 mm (No. 40)	30 max	50 max	51 min								
(iii) 0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
(b) Characteristics of fraction passing 0.425 mm (No. 40)											
(i) Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
(ii) Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min*
(c) Usual types of significant Constituent materials.	Stone Fragments Gravel and sand		Fine Sand	Silty or Clayey Gravel Sand				Silty Soils		Clayey Soils	
(d) General rating as subgrade.	Excellent to Good							Fair to Poor			

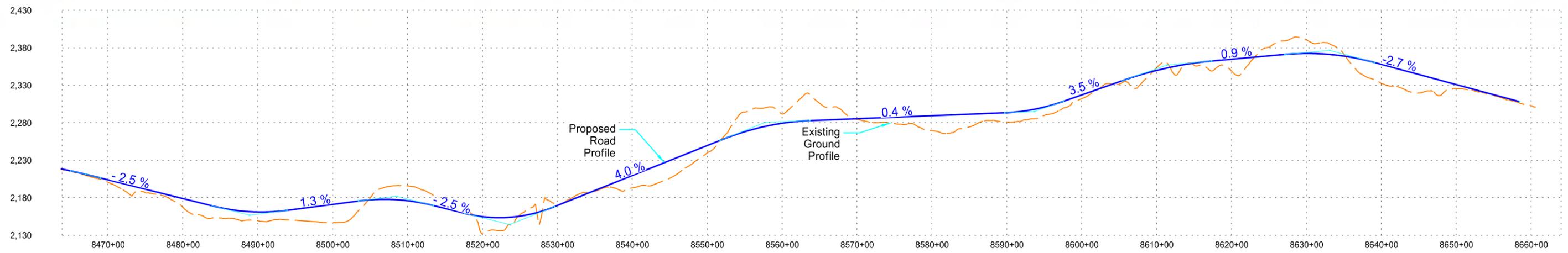
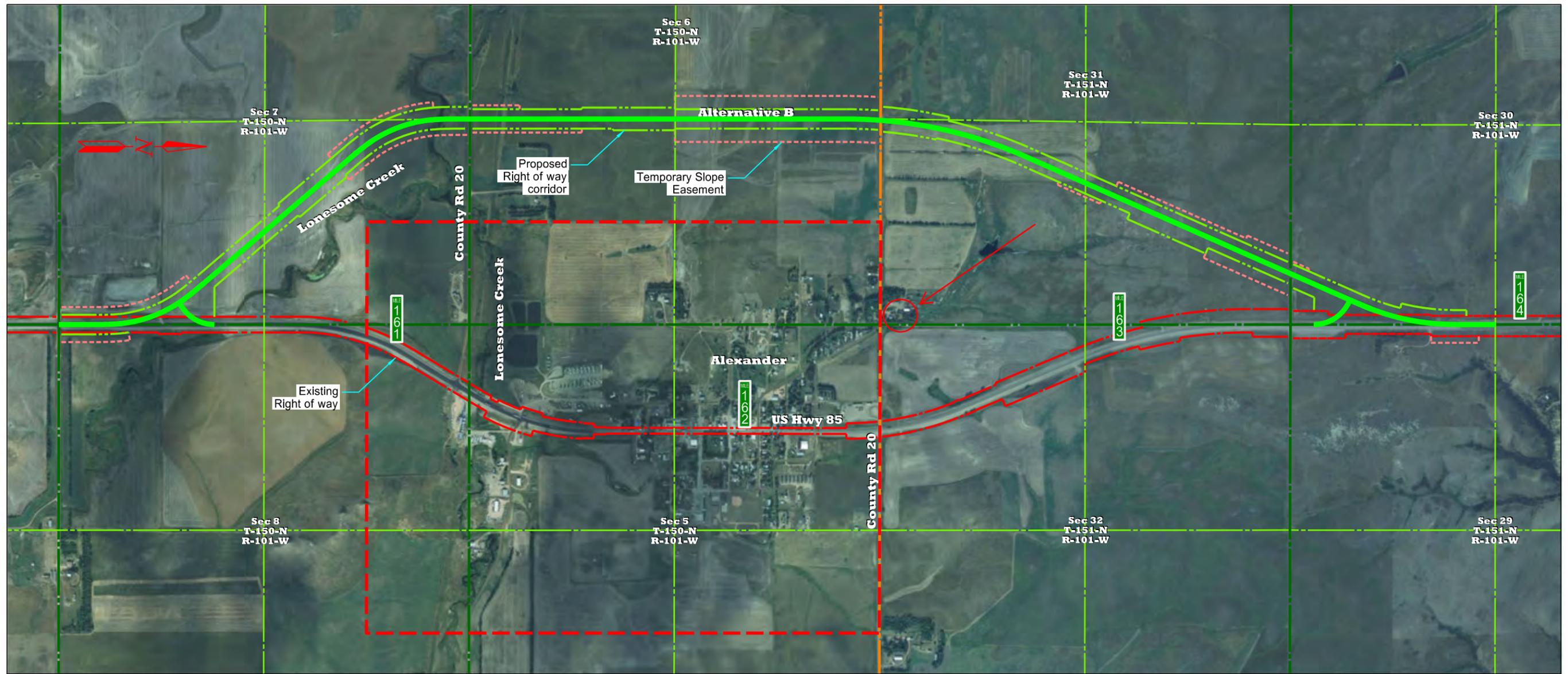
* If plasticity index is equal to or less than (Liquid Limit-30), the soil is A-7-5 (i.e. PL > 30%)
 If plasticity index is greater than (Liquid Limit-30), the soil is A-7-6 (i.e. PL < 30%)

Frost Susceptibility Index (Bases on US Army Corps of Engineers)

Frost Class	Frost Susceptibility	Soil Type	Percent Finer than 0.02 mm by weight %
F1	Negligible to Low	• Gravelly Soils	3 – 10
F2	Low to Medium	• Gravelly Soils • Sands	10 – 20 3 – 15
F3	High	• Gravelly Soils • Sands, except very fine silty sands • Clays, PI > 12	Greater than 20 Greater than 15 ---
F4	Very High	• All Silts • Very Fine Silty Sands • Clays, PI > 12 • Varved Clays and other fine-grained banded sediments	--- Greater than 15 --- ---

APPENDIX B

Alignment and Profile Alternative B



APPENDIX C

Boring Location Map



Legend

- Boring Locations

Project Number: SOIA-7-085(064)160

APPENDIX D

LAB RESULTS

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-37-2013	Date Reported	11/13/2013	District	Williston
County	MCKENZIE	Submitted By	Naumann	Project Number	NH-7-085(064)160A
AASHTO Test Method				PCN	19326

Comments

Lab Number	822	821	820	819
Reference Pt + Feet	8477+40	8480+90	8483+60	8486+05
Distance From CenterLine (Ft.)	Rt 0 SB	Rt 0 SB	Rt 0 SB	Rt 0 SB
Depth, Ft.	0.9 - 10.0	0.9 - 10.0	0.9 - 7.5	0.9 - 10.0
Field Sample No.	822	821	820	819
% Pass. 3/8" Sieve	100	99	100	99
% Pass. No. 4 Sieve	100	98	99	97
% Pass. No. 10 Sieve	98	96	98	95
% Coarse Sand (-No. 10 + No. 40)	5	5	4	5
% Fine Sand (-No. 40 + No. 200)	22	23	64	69
% Silt (0.074 - 0.005 mm)	33	30	16	9
% Clay (-0.005 mm)	37	39	15	12
Liquid Limit (-No. 40)	45	46	0	0
Plasticity Index (-No. 40)	28	31	NP	NP
Plastic Limit	17	16	0	0
Soil Color	BRN	BRN	BRN	BRN
Textural Class	CLY	CLY	SNDY LM	SNDY LM
Soil Class (AASHTO M-145)	A-7-6(18)	A-7-6(19)	A-2-4(0)	A-2-4(0)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	11.3	11.7	9.1	8.7
Maximum Dry Density (pcf)	124.6	125.4	127.1	124.8
% Organic Content				
Depth (Ft.) Moisture (%)	1 19.7	1 17.2	1 12.4	1 11.3
	2 15.9	2 16.7	2 14.8	2 8.4
	3 13.7	3 19.0	3 7.5	3 6.7
	4 17.6	4 20.4	4 8.1	4 4.8
	5 16.9	5 20.3	5 9.7	5 6.3
	6 17.6	6 20.6	6 11.5	6 9.9
	7 17.8	7 20.7	7 20.4	7 20.9
	8 17.3	8 19.5	8 19.1	8 22.9
	9 17.0	9 21.1	9 20.1	9 21.9
	10 16.2	10 20.8	10 21.3	10 20.5
Avg. Moisture of Sample Depth	16.8	19.6	12.1	13.4

Scott W. Wutzke, Testing Lab Supervisor

Date Printed: 12/23/2013

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-37-2013	Date Reported	11/13/2013	District	Williston
County	MCKENZIE	Submitted By	Naumann	Project Number	NH-7-085(064)160A
AASHTO Test Method				PCN	19326

Comments

Lab Number	818	817	816	815
Reference Pt + Feet	8488+55	8491+05	8493+55	8496+55
Distance From CenterLine (Ft.)	Rt 0 SB	Rt 0 SB	Rt 0 SB	Rt 0 SB
Depth, Ft.	0.9 - 10.0	0.9 - 6.0	0.9 - 10.0	1.5 - 10.0
Field Sample No.	818	817	816	815
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	99	100
% Coarse Sand (-No. 10 + No. 40)	1	2	3	3
% Fine Sand (-No. 40 + No. 200)	18	24	16	23
% Silt (0.074 - 0.005 mm)	40	42	39	36
% Clay (-0.005 mm)	41	32	41	38
Liquid Limit (-No. 40)	45	37	35	40
Plasticity Index (-No. 40)	29	20	18	27
Plastic Limit	17	18	17	13
Soil Color	BRN	BRN/BLK	BRN	BLK
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-6(23)	A-6(13)	A-6(13)	A-6(18)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	12.6	12.1	12.8	11.5
Maximum Dry Density (pcf)	121.2	122.2	119.4	123.0
% Organic Content				
Depth (Ft.) Moisture (%)	1 13.1	1 27.2	1 15.4	1 20.6
	2 11.4	2 30.0	2 12.7	2 9.5
	3 19.9	3 21.9	3 13.3	3 10.5
	4 22.5	4 23.5	4 18.8	4 19.3
	5 23.1	5 21.6	5 20.5	5 23.2
	6 26.5	6 18.2	6 24.1	6 19.6
	7 27.8	7 22.6	7 26.5	7 24.3
	8 26.5	8 23.6	8 25.9	8 24.1
	9 25.4	9 16.5	9 25.1	9 24.4
	10 21.0	10 19.4	10 27.3	10 24.6
Avg. Moisture of Sample Depth	21.7	23.8	21.0	19.9

Scott W. Wutzke, Testing Lab Supervisor

Date Printed: 12/23/2013

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-37-2013	Date Reported	11/13/2013	District	Williston
County	MCKENZIE	Submitted By	Naumann	Project Number	NH-7-085(064)160A
AASHTO Test Method				PCN	19326

Comments

Lab Number	813	814	812	808
Reference Pt + Feet	8498+80	8498+80	8501+85	8503+50
Distance From CenterLine (Ft.)	Rt 0 SB	Rt 0 SB	Rt 0 SB	Rt 0 SB
Depth, Ft.	2.5 - 5.5	5.5 - 10.0	3.0 - 10.0	0.7 - 7.0
Field Sample No.	813	814	812	808
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	99	100
% Coarse Sand (-No. 10 + No. 40)	0	1	4	1
% Fine Sand (-No. 40 + No. 200)	6	36	15	5
% Silt (0.074 - 0.005 mm)	42	37	22	56
% Clay (-0.005 mm)	52	26	58	38
Liquid Limit (-No. 40)	55	37	56	46
Plasticity Index (-No. 40)	36	23	37	28
Plastic Limit	19	14	19	18
Soil Color	BLK	BRN	BLK	BRN
Textural Class	CLY	CLY LM	CLY	SLTY CLY
Soil Class (AASHTO M-145)	A-7-6(36)	A-6(11)	A-7-6(30)	A-7-6(27)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	15.0	10.6	14.3	13.1
Maximum Dry Density (pcf)	116.2	128.6	118.7	119.6
% Organic Content				
Depth (Ft.) Moisture (%)	1 22.1	6 22.8	1 26.4	1 22.9
	2 18.4	7 24.0	2 20.9	2 21.6
	3 22.0	8 25.2	3 22.0	3 24.0
	4 25.0	9 21.7	4 25.5	4 16.1
	5 18.4	10 22.8	5 25.6	5 20.1
Avg. Moisture of Sample Depth	21.8	23.3	6 19.6	6 23.7
			7 33.3	7 14.0
			8 47.4	20.3
			9 35.6	
			10 36.6	
			30.7	

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Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

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Report Number	SS-37-2013	Date Reported	11/13/2013	District	Williston
County	MCKENZIE	Submitted By	Naumann	Project Number	NH-7-085(064)160A
AASHTO Test Method				PCN	19326

Comments

Lab Number	810	805	805.1	805.2
Reference Pt + Feet	8503+50	8506+35	8506+35	8506+35
Distance From CenterLine (Ft.)	Rt 0 SB	Rt 0 SB	Rt 0 SB	Rt 0 SB
Depth, Ft.	7.0 - 17.0	0.7 - 27.0	0.7 - 27.0	0.7 - 27.0
Field Sample No.	810	805	805.1	805.2
% Pass. 3/8" Sieve	100	100		
% Pass. No. 4 Sieve	100	100		
% Pass. No. 10 Sieve	100	100		
% Coarse Sand (-No. 10 + No. 40)	0	1		
% Fine Sand (-No. 40 + No. 200)	58	4		
% Silt (0.074 - 0.005 mm)	27	38		
% Clay (-0.005 mm)	16	58		
Liquid Limit (-No. 40)	0	67		
Plasticity Index (-No. 40)	NP	47		
Plastic Limit	0	20		
Soil Color	BRN	BRN	BRN	BRN
Textural Class	SNDY LM	CLY		
Soil Class (AASHTO M-145)	A-4(0)	A-7-6(50)		
Frost Class	F3	F3		
Optimum Moisture (%)	11.0	15.3		
Maximum Dry Density (pcf)	123.3	115.8		
% Organic Content				
Depth (Ft.) Moisture (%)	8 15.2	1 17.5	13 28.6	25 31.0
	9 9.7	2 15.9	14 27.6	26 24.1
	10 9.4	3 23.2	15 27.5	27 27.6
	11 11.2	4 25.8	16 18.0	27.5
	12 11.3	5 25.0	17 25.1	
	13 10.8	6 26.5	18 24.6	
	14 11.0	7 24.3	19 26.8	
	15 11.4	8 24.3	20 24.4	
	16 11.4	9 29.0	21 21.8	
	17 13.3	10 31.7	22 34.0	
Avg. Moisture of Sample Depth	11.5	11 32.8	23 35.5	
		12 26.4	24 23.9	
		25.2	26.5	

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Linear Laboratory Analysis

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Report Number	SS-37-2013	Date Reported	11/13/2013	District	Williston
County	MCKENZIE	Submitted By	Naumann	Project Number	NH-7-085(064)160A
AASHTO Test Method				PCN	19326

Comments

Lab Number	795	795.1	798	798.1
Reference Pt + Feet	8508+85	8508+85	8508+85	8508+85
Distance From CenterLine (Ft.)	Rt 0 SB	Rt 0 SB	Rt 0 SB	Rt 0 SB
Depth, Ft.	0.7 - 17.0	0.7 - 17.0	17.0 - 32.0	17.0 - 32.0
Field Sample No.	795	795.1	798	798.1
% Pass. 3/8" Sieve	100		100	
% Pass. No. 4 Sieve	98		100	
% Pass. No. 10 Sieve	97		99	
% Coarse Sand (-No. 10 + No. 40)	5		2	
% Fine Sand (-No. 40 + No. 200)	23		12	
% Silt (0.074 - 0.005 mm)	32		30	
% Clay (-0.005 mm)	36		56	
Liquid Limit (-No. 40)	42		55	
Plasticity Index (-No. 40)	27		37	
Plastic Limit	15		18	
Soil Color	BRN	BRN	BRN/GRY	BRN/GRY
Textural Class	CLY		CLY	
Soil Class (AASHTO M-145)	A-7-6(16)		A-7-6(33)	
Frost Class	F3		F3	
Optimum Moisture (%)	10.6		14.7	
Maximum Dry Density (pcf)	125.5		114.8	
% Organic Content				
Depth (Ft.) Moisture (%)	1 22.9	13 17.9	18 25.4	30 24.1
	2 16.7	14 21.4	19 25.1	31 19.3
	3 13.4	15 29.1	20 26.3	32 13.1
	4 15.6	16 25.3	21 26.3	18.8
	5 16.6	17 25.6	22 30.5	
	6 17.0	23.8	23 19.9	
	7 17.1		24 19.1	
	8 17.3		25 20.8	
	9 16.8		26 26.6	
	10 17.3		27 29.0	
	11 21.3		28 24.0	
	12 26.6		29 22.2	
Avg. Moisture of Sample Depth	18.3		24.7	

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